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A report on the economic and physical expansion of urban universities based on a case study of the Drexel Institute of Technology. The analysis of problems involved in the expansion of Drexel Institute focuses on six aspects of the total problem which were of immediate concern: (1) the economics of the high-rise building, (2) the economics of constructing low-building units which can be vertically expanded at a later date, (3) the conversion of industrial buildings to educational use, (4) the parking problem, (5) the arrangement and use of space to achieve high utilization, and (6) the determination of future space requirements.

Includes numerous photographs and designs of completed and planned facilities at several urban universities.

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SPACE AND DOLLARS: AN URBAN UNIVERSITY EXPANDS

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education

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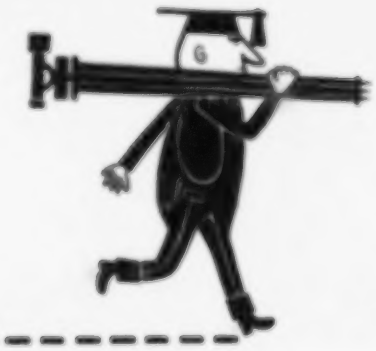

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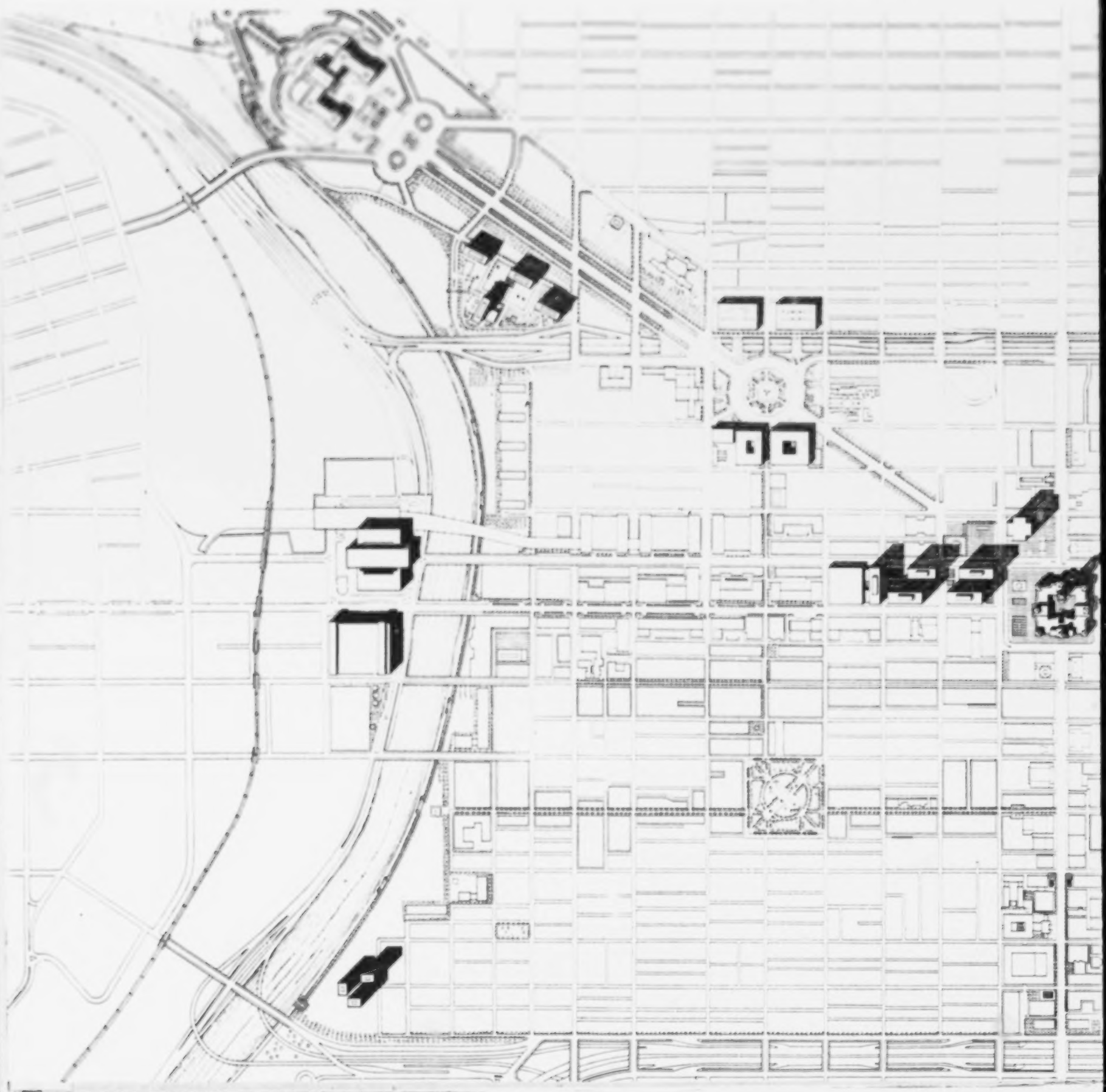
Section I



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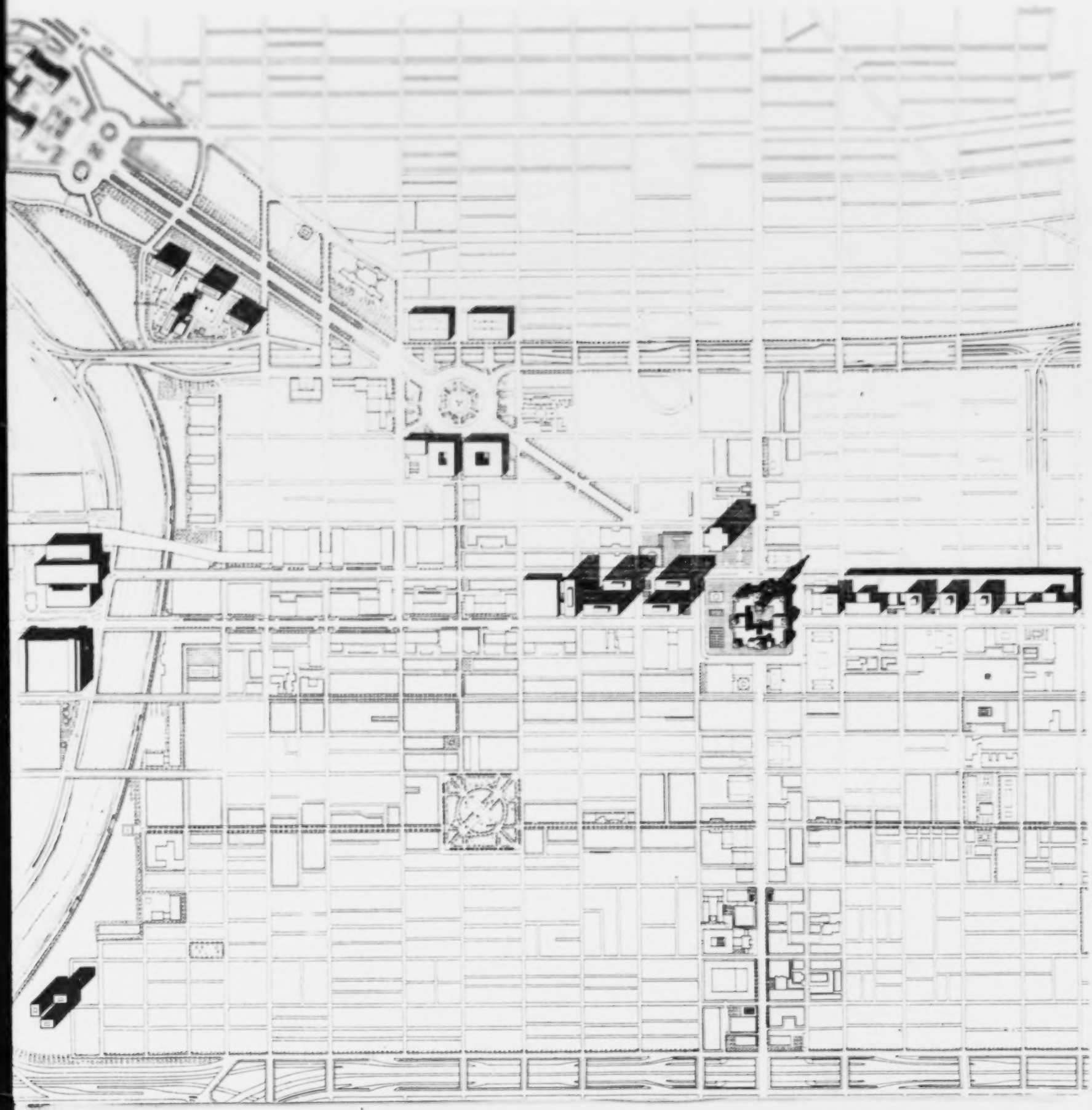

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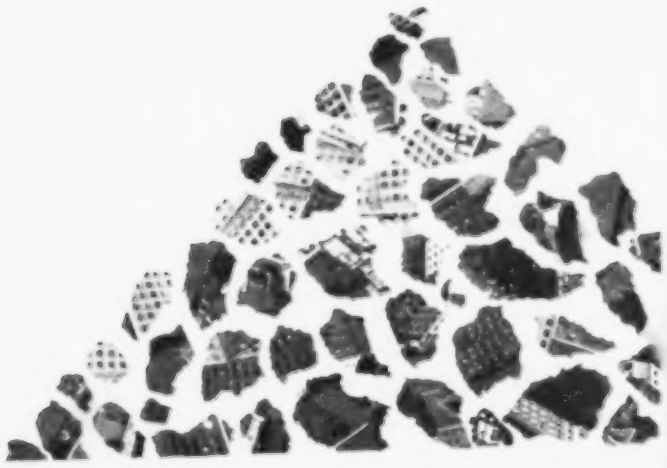

Section I

an urban university

CASE STUDIES OF EDUCA

Section 2

an urban university expands

BY RUTH WEINSTOCK

CASE STUDIES OF EDUCATIONAL FACILITIES #2

A report on the economic physical expansion of urban universities based on a case study of the Drexel Institute of Technology

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Section 2

The background

"Land is the most precious resource of the metropolitan area."
President John F. Kennedy, March 9, 1961.

THAT AMERICAN HIGHER EDUCATION is experiencing the greatest growth in its history is no longer news. Neither is it news that as a result of this enormous growth our colleges and universities are confronted with unprecedented problems. Indeed, the repetition of pronouncements on the matter has probably dulled our sensibilities in regard to it. The U. S. Office of Education estimates that within the next 10 years the number of students presently enrolled in institutions of higher education will increase by 100 per cent. This means that by 1970 there will be over six million young people in college. The same source informs us further that to accommodate this prodigious number, it will be necessary to spend some 18 bil-

Section I

lion dollars. This sum, roughly equivalent to the gross national product of Denmark, Finland, Greece, Norway, and Portugal combined, will be for the sheer *physical spaces alone*—classrooms, lecture halls, laboratories, dormitories, auxiliary facilities, land for the new buildings, *and rehabilitation of old ones.*

Eighteen billion dollars is so vast an amount that there is about it an air of unreality. But there is no unreality about the array of problems faced now, today, by educators and administrators across the country. Campuses are filled to capacity. Facilities must be expanded to meet present needs and to prepare for the future onslaught as well. Decisions must be made as to where and how to expand within the limits of available capital.

This, in general, is the broad background for this report which deals with six specific questions out of the many that bedevil those responsible for the expenditure of building funds. The six areas of inquiry taken up here are of special concern to one group of higher education institutions—those located in urban centers of metropolitan areas. These downtown institutions, whether they are located in Los Angeles or Philadelphia, New York or New Orleans, whether they are engineering colleges or liberal arts schools, share in common a constellation of problems deriving from the fact that they are all centrally located in large cities. They share in common, too, a vital interest in national and local programs aimed at restoring their cities from the blight of overcrowding, slums, and residential migration.

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Section 2

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These institutions represent one-tenth of all the higher education institutions in the United States (the American Association of Urban Universities estimates that they number about 200). Nevertheless they enroll over half of the entire college population of the country.

Thus the facts controvert the popular sentimental notion of American college students leisurely strolling to classes in ivy covered buildings set amid pastoral, leaf-strewn walks. The urban university has always attracted large numbers of students because of its accessibility to all the great cultural, industrial, financial, and research centers located in the urban community, because of its outstanding faculty members drawn from the community, and because it offers the student body greater outside learning opportunities. With the unprecedented numbers of young people who are now clamoring at the doors of higher education, the urban institution is destined to play an even greater role than it has in the past.

With an ever increasing proportion of students coming from lower- and middle-income families and the costs of college education increasing, many students will have to live at home and commute for full- or part-time study. The population of the United States is becoming increasingly concentrated in the metropolitan conglomerates. The downtown institution, because of its accessibility to transportation facilities, thereby becomes the logical choice for those young people who for economic reasons must remain at

Section I

home. Similarly, the location of the urban institution makes it a logical choice for evening students because of its proximity to large areas of employment.

By virtue of its geographical location, therefore, the urban institution fulfills a special function. Because it alone can provide its unique benefits the demands on it have grown and will continue to grow. By the same token, however, that of location, it is afflicted with special problems.

Most often its buildings are set down in the midst of densely populated areas, ringed by residential housing and/or commercial-industrial structures, closed off by building sites which are either unavailable or prohibitive in cost. These institutions find themselves landlocked. Expand they must, but where and how?

Some have attempted to solve the problem by the creation of satellite campuses on the edge of their cities or at a distance removed from the main body of the institution. This has in turn created new problems. Others weigh the cost of space in the air against space on the ground to see if the solution lies in multistory, vertical construction. Still others caught in the squeeze of crowded classrooms and limited capital consider the virtues of building low structures for immediate needs which can be expanded vertically at a later date to meet future enrollment growth. All are concerned with whether they are getting optimum use out of their present space.

These are perplexing questions. The answers to some of them mean breaking new ground, proceeding where precedent, making costly decisions where ther to draw upon. Some institutions, still at th problems, have not yet advanced to the poi questions to ask, what alternatives to weigh.

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Section 2

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exing questions. The answers to some of them mean breaking new ground, proceeding where there is little or no precedent, making costly decisions where there is scant experience to draw upon. Some institutions, still at the threshold of these problems, have not yet advanced to the point of knowing which questions to ask, what alternatives to weigh.

In the spring of 1958, Drexel Institute of Technology applied to Educational Facilities Laboratories for a grant to assist them with an analysis of the problems involved in the expansion of their plant. Drexel Institute is a representative urban institution. As such it could provide the setting for a case study. With the hope of developing a fund of information that could be drawn upon by comparable institutions, EFL acceded to Drexel's request.

The analysis conducted there was not intended as a comprehensive study of the entire gamut of college building problems. It focused on six aspects of the total problem which were of immediate concern to Drexel. It is these six areas of inquiry which are reported upon here.

The first step in the Drexel analysis was an examination of the use made of the existing plant. (For Drexel's findings and related data see Appendix I, The Arrangement and Use of Space to Achieve High Utilization.) The second step was the development of a method by which Drexel Institute could determine the quantity of future building space required to meet the needs of their ex-

Section I

pected growth. (For this method and related data see Appendix II, The Determination of Future Space Requirements.) The remaining areas of the study were devoted to investigations of the most practical and economical means by which to meet those needs (Sections 1 to 4).

The conclusions presented in this paper are Drexel's. They are based upon the research and data of Frederic C. Wood, Consulting Engineer, under whose direction and guidance the investigation at Drexel Institute was conducted.*

These findings, along with additional relevant information outside the scope of Drexel's researches, will not be applicable to every urban institution. But it is as much the purpose of this report to draw attention to some of the questions each institution must ask itself, to the alternatives that must be weighed, and to the lines of approach, as it is to supply answers.

* The major report to Drexel Institute bears a date of May 1, 1960. Requests for copies of this report should be addressed to the president of Drexel Institute of Technology, 32nd and Chestnut Streets, Philadelphia 4, Pa.

Section 2

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Section I

The case

DREXEL INSTITUTE OF TECHNOLOGY is a un
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Section 2

The case

DREXEL INSTITUTE OF TECHNOLOGY is a university with a total enrollment of 8,000 students located in the heart of downtown Philadelphia. It is centrally located and readily accessible by public and private transportation. It is open and in use from early morning until late at night throughout the year. Intensive, efficient use of the available plant has made it possible to provide educational services at a comparatively moderate cost and under circumstances which permit large numbers of persons to benefit.

Section I

Geographical location has been one of the major factors influencing the steadily increasing demands upon Drexel. These come from:

A Young high school graduates who live at home and commute to school. Four-fifths of Drexel's day students and almost 100 per cent of its evening and graduate students are commuters.

B Young people who wish to combine their college education with practical experience under Drexel's work-study program or who must, of necessity, earn while they learn. (Over 500 companies participate regularly in the Drexel work-study program or are represented by their employees in the evening graduate and undergraduate enrollments. Drexel's undergraduate students earned over $3.5 million in their work assignments last year.)

C Adults who are ambitious to advance themselves in their industrial employment by studying nights for the baccalaureate or master's degrees in scientific and technological fields.

D The several thousand companies of the greater Philadelphia area which are increasingly dependent on the Institute's graduates and which collaborate in research activities.

The Institute is now operating virtually at capacity. Further enrollment increases, extensions of existing programs, and introduction of new and critical curricula and educational services can be accomplished only by additions to staff and physical plant—this despite the fact that Drexel has not yet begun to serve the larger high school graduating classes of students who were the baby boom years. Moreover, a survey of attic ment undertaken in 1955 revealed that if the In maintains its present level of providing personnel f tional "markets" of the area in which it is located, i serve a minimum of 85 per cent more students by 19

While a central location has been, and will cont major factor in the steadily rising demand for Drexel services, it has also posed major problems inhibiti The essence of these problems is that land adjacent facilities is intensively used and therefore expensiv the limited reach of Drexel's funds.

The Institute's income is mostly from tuition a have been increased substantially in recent years. In Drexel's services available to all those who can benef there is a reluctance to raise fees much beyond their Nearly 90 per cent of operational costs have been source—and this has been possible only because use of the physical plant. The balance is met from an tions by alumni, foundations, and corporations, fr endowment income, and from a grant from the C of Pennsylvania. Endowment funds are so restricted stantial sums can be released for a purchase of land o ment of plant.

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Section 2

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high school graduating classes of students who were born during the baby boom years. Moreover, a survey of anticipated enrollment undertaken in 1955 revealed that if the Institute merely maintains its present level of providing personnel for the educational "markets" of the area in which it is located, it will have to serve a minimum of 85 per cent more students by 1970.

While a central location has been, and will continue to be, a major factor in the steadily rising demand for Drexel's educational services, it has also posed major problems inhibiting expansion. The essence of these problems is that land adjacent to the present facilities is intensively used and therefore expensive and beyond the limited reach of Drexel's funds.

The Institute's income is mostly from tuition and fees which have been increased substantially in recent years. In order to keep Drexel's services available to all those who can benefit from them, there is a reluctance to raise fees much beyond their present level. Nearly 90 per cent of operational costs have been met from this source—and this has been possible only because of the intensive use of the physical plant. The balance is met from annual contributions by alumni, foundations, and corporations, from a modest endowment income, and from a grant from the Commonwealth of Pennsylvania. Endowment funds are so restricted that no substantial sums can be released for a purchase of land or the development of plant.

Clearly, the rate at which capital funds can be accumulated for

Section I

physical expansion makes it imperative that available capital be used with the utmost care and foresight if foreseeable demands for educational services are to be met.

So much for the statement of the Drexel case. In a number of respects it mirrors the situation of many urban educational institutions.

One solution that immediately suggests itself is to retreat to the country where space is more easily come by. Rider College, a 95-year-old institution, found itself throttled by its location in the center of Trenton, New Jersey, so it bought 142 acres on the outskirts of the city and is building a new campus. This cannot be recommended as a general solution, however, since it would be obviously inconsistent with the function of an urban university to be located in the country. Realism clearly dictates that the solutions must be found within the context of the geography and economics of urban life.

The challenge of Drexel and similarly situated institutions is to find a *modus operandi* that can convert the problem into its opposite and change the burden into a benefit. The key is in maintaining a highly efficient level of plant utili
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Section 2

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taining a highly efficient level of plant utilization, thereby capitalizing on the increased enrollment by using its revenue to reduce overhead costs. The funds thus saved can then be used to pay faculties of high standing and to forestall tuition increases which might deprive many urban young people of educational opportunity.

The six areas of inquiry

Section I

No newcomer to the high-rise bui
began using vertical structures fo
the Twenties.

LEFT TO RIGHT:
Ten and a half-story main build
converted in 1927 from a book pu

Loeb Students Center, 11 stories
and Abramovitz, architects.

NYU's newest, the Graduate Sch
tion, located in the city's downt
7 floors of the 10-story building
classrooms from street noises. W
ing classes make up large part of
Owings, and Merrill, architects.

I. THE ECONOMICS OF THE HIGH-RISE BUILDING

Back in 1936 when Gertrude Stein described the United States as a country with "more space where nobody is than where anybody is," she was quite correct. The passing years have proven her a prophet as well as a poet, for the American population has grown in leaps and bounds and the greatest growth has been where there is the least room for it—in the metropolitan areas. Space is tighter than ever before in our history and what there is has become increasingly expensive. As a result, urban buildings are more vertical than ever. College and university buildings are no exception. Within the past few years one well-known urban university has had to pay $1,800 per front *inch* of space for two city blocks on which to build. So educational buildings too, though they have been traditionally three- or four-story and basement structures, are being pushed up.

THE HIGH-RISE TREND IN EDUCATIONAL BUILDINGS. Some institutions, notably New York University and Columbia, have been using tall buildings for some time, but there is now a marked trend on a nation-wide scale toward the vertical structure. Harvard and Cornell are both planning dormitories above the former 4-story level. (Since educational buildings have been customarily limited to 4 stories, anything exceeding that level, or maximum walk-up height, can be considered high-rise.) Among 9 buildings proposed for construction in the next 10 years
go up to 20 stories. Boston University has
for a new high-rise campus in which several
stories will be erected. Even universities
campuses will soon have a vertical look. T
fornia at Los Angeles, with a 411-acre cam
ings that will rise up to 12 stories instead o
past, so that they can retain sizable landsc
ation areas. The expansion program at Berk
buildings will be limited to 25 per cent of t
buildings that will rise vertically in order to
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This does not mean that space in the air
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and down. Elevators and escalators cost mo
is which costs less—space on the ground (if
or the installation and use of vertical tra
which is an essential of space in the air.

Section 2

No newcomer to the high-rise building, New York University began using vertical structures for education as far back as the Twenties.

LEFT TO RIGHT:
Ten and a half-story main building at Washington Square, converted in 1927 from a book publisher's loft.

Loeb Student Center, 11 stories, opened in 1959. Harrison and Abromovitz, architects.

NYU's newest, the Graduate School of Business Administration, located in the city's downtown financial district. First 7 floors of the 10-story building are windowless to insulate classrooms from street noises. Wall Street executives attending classes make up large part of the student body. Skidmore, Owings, and Merrill, architects.

MICS OF THE HIGH-RISE BUILDING

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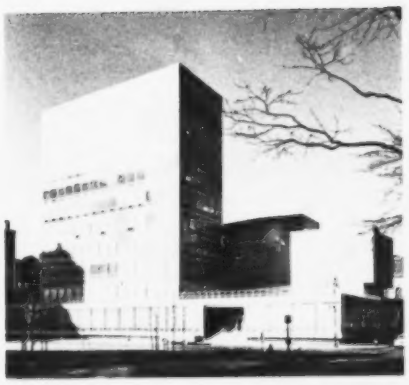
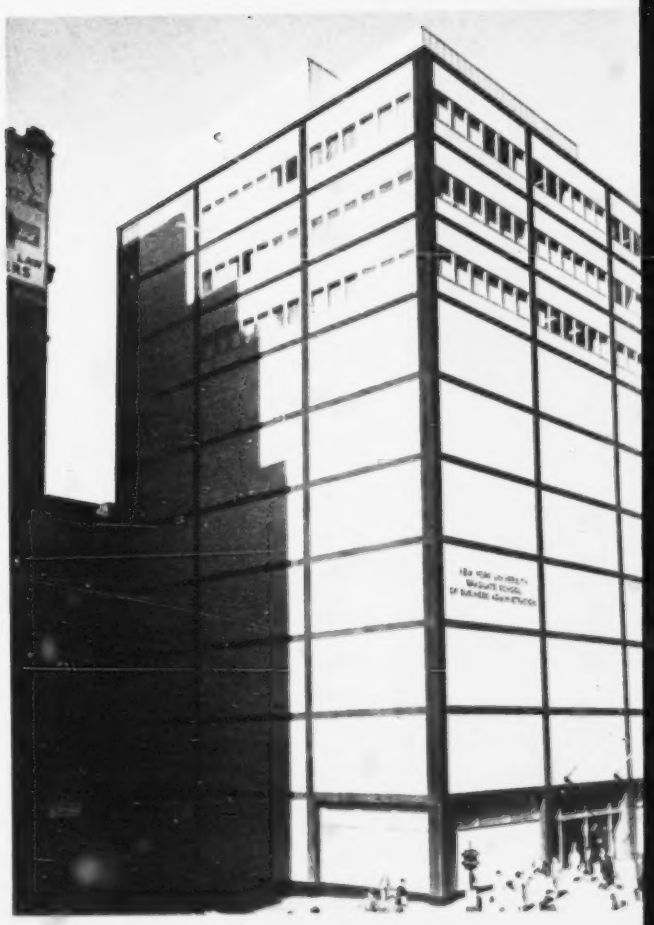
considered high-rise.) Among 9 buildings proposed for construction in the next 10 years at MIT, at least 4 will go up to 20 stories. Boston University has a 10-year master plan for a new high-rise campus in which several buildings of 15 or 16 stories will be erected. Even universities with large, sprawling campuses will soon have a vertical look. The University of California at Los Angeles, with a 411-acre campus, is planning buildings that will rise up to 12 stories instead of only 3 or 4 as in the past, so that they can retain sizable landscaped courts and recreation areas. The expansion program at Berkeley is planned so that buildings will be limited to 25 per cent of the 178-acre site, with buildings that will rise vertically in order to maintain open, park-like vistas. And though the problem has a somewhat different dimension because there is a wider range of choices available to them, institutions located in the country, with rural land values, are arriving at a point where they, too, must consider a certain degree of high density desirable. If they do not control their growth carefully they risk having campuses which are too widespread and very costly to operate.

This does not mean that space in the air does not have its own price. Intrinsic to the high-rise building are the elevator and/or escalator, the mechanical means for moving people and things up and down. Elevators and escalators cost money, too. The question is which costs less—space on the ground (if it is there to consider) or the installation and use of vertical transportation machinery which is an essential of space in the air.

Section I





Drexel Institute of Technology undertook an investigation into the feasibility of multistory buildings for its own plant. The investigation was confined to buildings with elevators and centered on two basic questions:

A At what price in the cost of land is a detailed study of the economics of high-rise buildings indicated?
B What operating problems may high-rise buildings present?

THE ECONOMICS. An obvious rule of thumb on the economics of the high-rise building is that where land costs are high or where land is scarce, greater use must be made of it. However, the primary consideration in each case is the relationship between the cost of ground and the ultimate cost of elevators. (Although the price of vertical transportation is not the only cost factor which must be considered, see p. 18, it is the most significant one.)

Illustratively, an average educational building of 40,000 square feet with basement and three floors, with a ground area of 10,000 square feet, would require one elevator. Many of these "average" educational buildings, consisting of three stories and a basement, are over 30 years old. At the time they were constructed it was virtually unheard of to install elevators in such low structures. These buildings were thought of simply as walk-ups. But in the years since then as the use of mechanical equipment became common practice, it became the custom to include elevators in all such buildings. Most often these elevators are not used
Many of them are not even equipped with butto
They are key-operated and the custodian or a fa
the keeper of the key. Occasionally a disabled s
member may ride instead of walk, but for the m
used by maids and custodians for janitorial work
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This prototype building was chosen by Drexel
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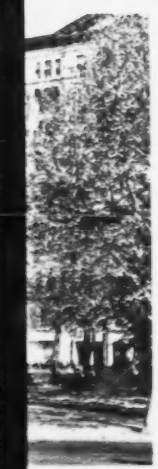

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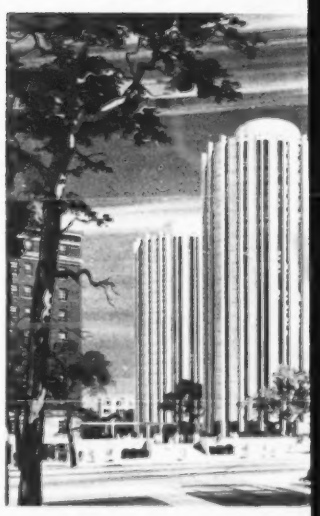
buildings. Most often these elevators are not used to move people. Many of them are not even equipped with buttons at the floors. They are key-operated and the custodian or a faculty member is the keeper of the key. Occasionally a disabled student or faculty member may ride instead of walk, but for the most part they are used by maids and custodians for janitorial work or the moving of supplies and equipment.

This prototype building was chosen by Drexel as the basis for comparison.

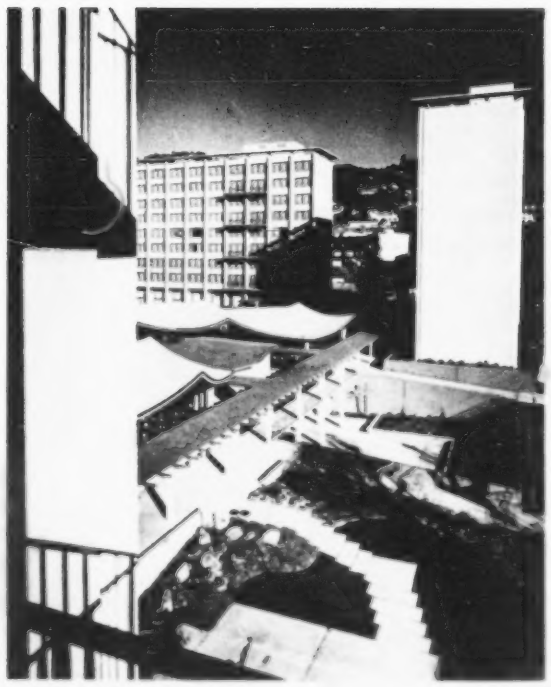
Drexel's research found that the elevator in this building would cost about $45,000. Two such buildings to provide twice as much space would require two elevators. Up to this point the two buildings would be equal in cost. However, if the same 10,000 square feet of ground area were used to provide a seven-story and base-

Section I

▲ *Columbia University, another high-rise veteran: Its 12½-story Pupin Physics Building went up in 1925. McKim, Mead, and White, architects.*



► *Triple towers, 15, 18, and 21 stories tall, are main design feature of new men's dormitory to be erected by University of Pittsburgh. Despite appearances, dormitory is actually one building; circular towers rest on a common 3-story pedestal. Deeter and Ritchey, architects.*



◄ *Vertical residence surround a recreation on the Berkeley cam University of Califo John Carl Warnecke Associates, architects.*

Section 2

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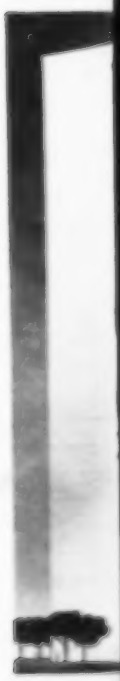
◄ *Vertical residence halls surround a recreation court on the Berkeley campus, University of California. John Carl Warnecke and Associates, architects.*

Section I

◀ *Chadbourne Hall, 11-story women's residence at University of Wisconsin, is "Y" shaped. Roof deck permits girls to sun and lounge. Stanley Nerdrum, architect.*

► *To beat institutional bigness of mass living quarters, high-rise interiors are often organized into small "houses". This one, University of Chicago's new 10-story Pierce Hall, has its houses built in. Each 2 floors contains its own double-story lounge, a kitchen, laundry and bedrooms. Harry Weese and Associates, architects.*



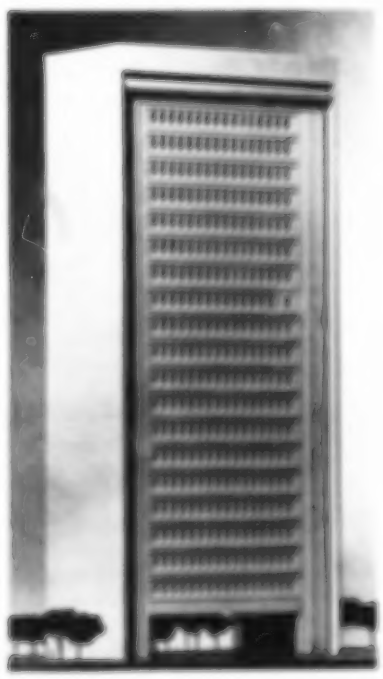
► *Choked by urban congestion, Massachusetts Institute of Technology is planning 5 new high-rise structures. This one, 20 stories tall, is for the study of earth sciences. I. M. Pei, architect.*

Section 2

◀ *Chadbourne Hall, 11-story women's residence at University of Wisconsin, is "Y" shaped. Roof deck permits girls to sun and lounge. Stanley Nerdrum, architect.*

◀ *A mass of brick stacks extend upward at the Richards Medical Research Building, University of Pennsylvania. Stacks contain service equipment and act as nostrils, inhaling air from gardens in rear; air is circulated then expelled up and out. Louis I. Kahn, architect.*

▶ *Choked by urban congestion, Massachusetts Institute of Technology is planning 5 new high-rise structures. This one, 20 stories tall, is for the study of earth sciences. I. M. Pei, architect.*



Section I

ment building (equivalent in area to two three-story and basement buildings), two elevators would probably not be adequate. Most likely a third would be necessary. The third elevator, therefore, would cost an additional $45,000. Since it would be serving a building standing on 10,000 square feet of ground, the cost of the additional third elevator would be $4.50 per square foot of ground.

THE EVIDENCE. From this it was concluded that, since the minimum cost of the additional elevator which would *probably* be required by the higher building would be equivalent to land at $4.50 per square foot, when the cost of land approaches this figure a detailed study should be made of all the cost factors involved.

ADDITIONAL COST FACTORS. There are considerations beyond the purchase and installation price of elevators alone, though their cost is the major one, which affect the ultimate total cost of the high-rise building. One such factor would be the particular use of the building itself. The proportion of space and the location of space for classrooms, lecture rooms, teaching laboratories, and offices will determine the number, size, and type of elevators needed. In some cases the third elevator in the hypothetical building discussed might not be necessary, in others a fourth might be required.

Still other factors which add to the cost o
and need to be considered are these:

a. The effect of local building code requirements
since a high ratio of fire exits, stairs, and
b. Added cost of heavier structural columns.
c. Larger ventilating ducts.

On the other hand, factors which will cost
ing as against two lower ones are:

a. Foundations.
b. Excavation.
c. Roof and flashings.
d. Landscaping.
e. Maintenance and custodial work, and
f. Bringing utilities to the building.

Finally, the effect of elevators on the n
building must be weighed. While the highe
space for the elevators and may possibly re
the stairways, it will also use less space f
receiving, and custodial storage.

It must be pointed out that the figure of
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Section 2

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Still other factors which add to the cost of a high-rise building and need to be considered are these:

a. The effect of local building code requirements which may necessitate a high ratio of fire exits, stairs, and walkways.
b. Added cost of heavier structural columns, and
c. Larger ventilating ducts.

On the other hand, factors which will cost less in one high building as against two lower ones are:

a. Foundations,
b. Excavation,
c. Roof and flashings,
d. Landscaping,
e. Maintenance and custodial work, and
f. Bringing utilities to the building.

Finally, the effect of elevators on the net usable space of the building must be weighed. While the higher building uses more space for the elevators and may possibly require more space for the stairways, it will also use less space for entrances, lobbies, receiving, and custodial storage.

It must be pointed out that the figure of $4.50 per square foot of ground as the cut-off point for considering a high-rise structure applies to the 7-story and basement building which was the height

Section 5

Drexel chose to investigate, since this was most appropriate for their needs and total environment. A building taller than 7 floors, however, might have yielded a somewhat different picture since the cost of an elevator increases the higher up it goes. A 7-story elevator will cost just a slight bit more than one that goes up 4 stories, but not enough more to alter substantially the final mathematics. A 10-story or 12-story elevator might present a somewhat different final picture. However, it is beyond 12 floors that the cost of elevators really begins to pyramid because it becomes necessary to use geared rather than gearless elevators in order to obtain the greater speed needed. Most low-cost housing, for example, goes up to 12 stories for this reason.

OPERATING DIFFICULTIES. It was concluded from visits to other universities using multiple story buildings and from discussions with the elevator companies that there are no serious problems with elevators in buildings up to 12 floors high. (Assumptions in this study are based upon self-service elevators that do not require operators, but in non-self-service units the possibility of union strikes is always present as a potential difficulty.) Various methods can be used to expedite traffic, such as keeping classrooms on the lower 3 or 4 floors and using the upper floors for faculty offices and faculty research so there are fewer people to be moved up and down. Another expedient is that of having elevators stop at every other floor.

Beyond 12 floors however, just as the cost of e
up, so do the operating problems. Some institution
densely occupied by classrooms on upper floors ha
ple with serious and persistent traffic jams with th
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nuisances. For the most part, however, the purpose
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concentrated populations on upper floors, the vert
of people presents no special difficulties—the tot
unusually heavy and it is spread over an extended
However, if the upper floors contain classrooms o
elevators capable of moving large numbers of pe
specific hours will be required. This increases the
and the number of elevators. There is no reasonable
what modern vertical transportation equipment w
everything else the more you increase its capacity
increase the cost.

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Beyond 12 floors however, just as the cost of elevators shoots up, so do the operating problems. Some institutions with buildings densely occupied by classrooms on upper floors have had to grapple with serious and persistent traffic jams with their consequent hazards to safety, lateness to classes, and other more minor inconveniences. For the most part, however, the purpose for which the building will be used determines the nature of the operating problems. For a dormitory or research laboratory which does not have concentrated populations on upper floors, the vertical movement of people presents no special difficulties—the traffic load is not unusually heavy and it is spread over an extended period of time. However, if the upper floors contain classrooms or lecture halls, elevators capable of moving large numbers of people rapidly at specific hours will be required. This increases the size, the speed, and the number of elevators. There is no reasonable limitation on what modern vertical transportation equipment will do, but like everything else the more you increase its capacity, the more you increase the cost.

Buildings for educational purposes higher than a walk-up distance are perfectly feasible and practical, if properly planned, and are not uncommon. The need for these higher buildings is determined by the cost of the land or the availability of the land where it is needed as measured against the total cost of the vertical transportation facility and that, in turn, is determined by the use and height of the structure.

Section I

Making small buildings bigger by adding stories is a time-honored practice in commercial structures. This one, W. T. Grant store in Portland, Maine, had 2 stories added on to 1900. Cladding of original building can be seen on brick wall before it was cleaned.

II. THE ECONOMICS OF CONSTRUCTING LOW BUILDINGS ONTO WHICH CAN BE VERTICALLY EXPANDED AT A LATER DATE

Educational institutions short of space and short of money are often forced into cutting corners and making compromises that will squeeze their planned buildings into their budgets. But compromise, when it is not prudent, can be very costly. In the physical expansion of a university the compromise which is most imprudent is the one which trades long-range planning goals for stopgap solutions. Naturally this is most apt to happen where enough funds are not available for both present and future needs. Institutions in this situation find themselves caught between two compelling urgencies. On the one hand there is the immediate demand for increased space to relieve the pressures of the moment. On the other hand there is the steady tempo of growth with its accumulating pressures, predictable over the years, which calls for long-term planning and building toward the future. Normally these two are not incompatible. However, where a university is able to acquire its building funds only gradually, there sometimes seems to be no choice but the one that will solve immediate problems, leaving future space needs for a future time when additional funds will have been acquired. But this is a very expensive course to follow.

Putting up a 3-story building, when an 8- or 12-story building

ultimately will be needed, on urban land so
by the square foot, is enormously wasteful.
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sands of dollars in land costs.

However, with the resignation of the pos
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Drexel Institute of Technology is one of t
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limitations of its present funds, it looked t
stallment building as a possible solution to
end an investigation was set up to explore
erecting low building units, in answer to the
diate space, which could be vertically expa
when additional building funds could be
the methods and findings of that inquiry.

Section 2

...ing small buildings began by adding stories to a one-humored ...ture in commercial structures. This one, W. T. Grant store in ...land, Maine, had 2 stories added on in 1949. Outline of original ...ing can be seen on brick wall before it was sheared.

...NOMICS OF CONSTRUCTING LOW BUILDINGS
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However, with the resignation of the poor who often feel that economy is a luxury only the rich can afford, the stopgap course is the one that is frequently followed even with the full knowledge that in the end the price is higher.

Drexel Institute of Technology is one of those universities which does not have large reserves of building capital from which to draw. It can only acquire such funds gradually. Anxious to avoid the burden of greater ultimate expenditures caused solely by the limitations of its present funds, it looked to the feasibility of installment building as a possible solution to the dilemma. To that end an investigation was set up to explore the economics of constructing low building units, in answer to the need for more immediate space, which could be vertically expanded at a later date when additional building funds could be accumulated. Here are the methods and findings of that inquiry.

Section I

A modest 5 stories when first built in 1955, this garage and building on Sixth Avenue near Grand Central Terminal in York, will grow into an imposing 20-story office structure. I increasing value of location is the reason.

Photo shows original 5-story structure. Though not seen here ing had an odd appearance due to elevator banks which ex 5 stories beyond the roof in expectation of expansion to 9 See next page for its subsequent growth.

THE METHOD. A typical educational building was selected which was 50 feet wide with columns not placed in the center, allowing for offices on one side of the building with a corridor and classrooms or laboratories on the opposite side. The live load was assumed at 60 pounds per square foot.

The structural engineering firm of Seelye, Stevenson, Value, and Knecht of New York City was employed to actually design the foundations, the columns, the floor slabs, and the roof slabs for a typical 20 by 50 foot bay of such a building. Foundations were designed for average soil conditions and also for poor soil conditions which would necessitate using piles. The building was first designed as a 3-story and basement building with no provision for vertical expansion. It was then designed with provision to expand it to 9 floors and also to 12 floors.

The only significant variation in the design of these buildings obviously would be in the size of the columns and footings. The floor and roof slabs would be the same whether the building was designed for vertical expansion or not.

The structural designs were turned over to Professional Estimators, Inc. of Princeton, N.J., who established actual costs for the columns and footings under the various schemes considered. These costs were divided by the number of square feet in the building.

The results are shown in this table:

The Cost of Columns and Column Footings for a Basement Reinforced Concrete Building
(Costs are per square foot of gross building area)

	AVERAGE FOUNDATION
No provision for expansion	$ .57
Expandable to 9 stories	$1.41
Premium for expansion to 9 stories:	$ .84
Expandable to 12 stories	$1.92
Premium for expansion to 12 stories:	$1.35

Note: Modern buildings often carry a great deal equipment, such as fans and air-conditioning ap roof. In expanding a building vertically it is not ne all this equipment to a new roof. The mechanical as the top of the initial building and be located i the ultimate building. Only the elevator machine be moved up in an ultimate vertical expansion.

THE FINDINGS. The figures indicate that where are average it costs but little extra to prepare t column footings in a three story and basement will be adequate for ultimately carrying the build 12 stories. If a typical college building can be assu per square foot, then the 84¢ additional cost per

Section 2

A modest 3 stories when first built in 1955, this garage and office building on Sixth Avenue near Grand Central Terminal in New York, will grow into an imposing 20-story office structure: rapidly increasing value of location is the reason.

Photo shows original 3-story structure. Though not seen here, building had an odd appearance due to elevator bunks which extended 3 stories beyond the roof in expectation of expansion to 9 stories. See next page for its subsequent growth.

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in this table:

The Cost of Columns and Column Footings for a Three-Story and Basement Reinforced Concrete Building
(Costs are per square foot of gross building area)

	AVERAGE FOUNDATION	PILE FOUNDATION
No provision for expansion	$ .57	$1.05
Expandable to 9 stories	$1.41	$2.26
Premium for expansion to 9 stories:	$ .84	$1.21
Expandable to 12 stories	$1.92	$3.00
Premium for expansion to 12 stories:	$1.35	$1.95

Note: Modern buildings often carry a great deal of mechanical equipment, such as fans and air-conditioning apparatus, on the roof. In expanding a building vertically it is not necessary to move all this equipment to a new roof. The mechanical floor can serve as the top of the initial building and be located in the middle of the ultimate building. Only the elevator machines would have to be moved up in an ultimate vertical expansion.

THE FOOTINGS. The figures indicate that where soil conditions are average it costs but little extra to prepare the columns and column footings in a three story and basement building so they will be adequate for ultimately carrying the building up to 9 or 12 stories. If a typical college building can be assumed to cost $20 per square foot, then the 84¢ additional cost per square foot of

Section I

gross building area to provide for going up to 8 stories would represent about 4 per cent of the original cost. This is sufficiently small to be recommended wherever land is costly or in short supply. The premium of $1.35 per square foot to make the smaller building expandable to 12 stories is still only an increase of about 6 per cent and should also be considered.

However, where soil conditions present problems and the building must be set on pile foundations, the premium of $1.95 per square foot of gross building area to make the smaller building expandable to 12 floors represents an additional cost of about 9 per cent. In some cases this might be too much of an increase to be an economical course to follow.

It must be pointed out, though, that even an additional 9 per cent to provide for expansion in advance is much less costly than a later expansion where no provision has been made for it. Memorial Hospital in New York City, which is currently planning a vertical expansion of a 3-story section of its building to 13 stories

in order to provide desperately needed bu
The original planners, 20 years ago, antic
for future expansion of two wings of the
reason overlooked a third. This area was no
footings and columns. As a result, new
new foundations must be cut through the ex
to provide the additional space. Not only
be substantially more than 9 per cent, but
be interrupted while the construction is in
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venient for the building's occupants during
tion but it continues to be possible to use th

Serious consideration should be given th
fore rejecting the additional cost of 9 per
and the costs of alternative procedures shou
and compared.

LEFT, the 5-story building of 1915 as it looked 2 years later, "on the addition of 5 more stories.

RIGHT, same building, but this time 20 stories—as it will be after 12 additional floors are placed on top of present structure. Original foundations were built strongly enough to support future growth. Kahn and Jacobs, architects.

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in order to provide desperately needed beds, is a case in point. The original planners, 20 years ago, anticipated a possible need for future expansion of two wings of the building, but for some reason overlooked a third. This area was not provided with heavier footings and columns. As a result, new structural columns with new foundations must be cut through the existing building in order to provide the additional space. Not only is the cost expected to be substantially more than 9 per cent, but use of the building will be interrupted while the construction is in progress. Where provision has been made for expansion in advance, it may be inconvenient for the building's occupants during the period of construction but it continues to be possible to use the building.

Serious consideration should be given the matter, therefore, before rejecting the additional cost of 9 per cent as uneconomical, and the costs of alternative procedures should be carefully weighed and compared.

Section I

III. THE CONVERSION OF INDUSTRIAL BUILDINGS TO EDUCATIONAL USE

The existence of vacant land any place in the crowded, bustling neighborhood of a downtown university is of course a great rarity. Precisely because it is what it is, the urban institution is surrounded by a variety of buildings, usually of a commercial or industrial character. To acquire land for more building space, urban universities often buy these old structures, demolish them, and erect completely new buildings on the cleared site. Ordinarily, too little thought is given to the possibility of adapting the existing structures to the educational uses of the institution.

One exception, though, is New York University's main building at Washington Square, a 10½-story structure converted in 1927 from a loft which housed a book publishing company. Its School of Commerce building, too, started life as a light manufacturing loft, which was converted to educational uses in 1928. Even in those more halcyon days for building, it was sometimes cheaper to convert than to raze and start building afresh.

ADVANTAGES OF CONVERSION. Considerations of time, money, esthetics, and even practical politics enter into any conversion. (Not the least of these is the difficulty of raising funds for remodeling purposes when a new building which can carry the name of a donor has greater appeal.) There obviously can be no rule which applies to all situations, but here are some reasons for considering conversion.

Except in unusual circumstances, old buildings do [illegible] structurally. Foundations, walls, beams, and floor-[illegible] relatively intact. The parts that require renewal [illegible] floors and walls, ceilings, and, more particularly, [illegible] parts such as wiring, plumbing, heating, and ventila[illegible]

It is estimated that old buildings generally have a [illegible] of $10 a square foot. To demolish 100,000 square [illegible] therefore, could be tantamount to reducing one [illegible] worth of structural space to dust and rubble. To [illegible] way, the cost of remodeling an old building may run [illegible] that of erecting a new one.

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Except in unusual circumstances, old buildings do not deteriorate structurally. Foundations, walls, beams, and floor-framing remain relatively intact. The parts that require renewal are finishes on floors and walls, ceilings, and, more particularly, the mechanical parts such as wiring, plumbing, heating, and ventilating.

It is estimated that old buildings generally have a residual value of $10 a square foot. To demolish 100,000 square feet of building, therefore, could be tantamount to reducing one million dollars' worth of structural space to dust and rubble. To put it another way, the cost of remodeling an old building may run about one-half that of erecting a new one.

There are, of course, exceptions. The poor fire resistance of some old buildings is one such example. More account would need to be taken of the added cost of introducing modern fire resistant means of egress and ingress, or automatic sprinklers. Whether the building would be used as a laboratory or a dormitory involving fire hazards greater than in other possible uses, is another question that would have to be carefully looked into. Either of these might weight the scales on the side of an entirely new building.

In those buildings where it is feasible, however, there is an additional advantage to conversion that deserves reflection. That is the savings in time. Planning time is shortened in that the size and

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chape of the building are already determined—little in the way of structural design is needed as it is already there. The time for excavation and building of the foundations and the structure itself, exclusive of its exterior walls or interior walls, finishes, and mechanical equipment, usually takes a minimum of nine months. Most of this time can be saved, for such demolition of parts of the old building as may be necessary can be done while plans for the alterations are being drawn. It might conservatively be estimated that the conversion of a 100,000 square foot structure to a new use could save a full year as against tearing it down and building a new one.

These considerations of the savings in time and money are becoming more important daily. Where it is practicable to do so, the conversion of old buildings to educational use can accomplish both these ends. As one means of physical expansion, therefore, it is a matter which deserves serious exploration.

Drexel Institute did just such an exploratory survey. Because the general approach used to the particular situation on the Drexel campus may suggest a procedure useful to other universities, it is presented here.

CONSIDERATION OF A WAREHOUSE TO POSSIBLE EDUCATIONAL SPACE AS DREXEL INSTITUTE. Drexel Institute is located in an area certified for redevelopment and would eventually receive special assistance through the established urban renewal channels. However, pres-

sure on their existing facilities made imperative expansion of teaching space. The immediate pre the fact that a large class of freshmen had to fall of 1959 in expectation that space to accom dents as juniors in 1962 could be built or rent

Little open land of a completely satisfactor be located in the neighborhood or at reasonable of 18 to 24 months delay was involved in ac land through redevelopment channels, with a write-down assistance.

Immediately behind the main buildings of was a seven-story, furniture warehouse build on the market for sale and which, in the norm might have been included in a Drexel contract ment Authority and torn down. The cleared la been made available to Drexel.

However, in view of the urgency of the situ to weigh the possibility of adapting the old w purposes. To enable them to arrive at a sound analysis was required of all the relevant ass which would bear on a) remodeling or b) de ing anew. The analytic procedure set up for t the following steps.

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Red Lion Garage. Warehouse (inside circle) will undergo brick and block transformation, take on new identity and character as an academic building for Drexel Institute. Supervisor and Demchick, architects.

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ADAPTATION TO INSTRUCTIONAL SPACE AT DREXEL

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sure on their existing facilities made imperative an immediate expansion of teaching space. The immediate pressure stemmed from the fact that a large class of freshmen had been admitted in the fall of 1959 in expectation that space to accommodate these students as juniors in 1962 could be built or rented.

Little open land of a completely satisfactory character could be located in the neighborhood or at reasonable terms. A minimum of 18 to 24 months delay was involved in any attempt to obtain land through redevelopment channels, with or without benefit of write-down assistance.

Immediately behind the main buildings of the Institute there was a seven-story, furniture warehouse building which had been on the market for sale and which, in the normal course of events, might have been included in a Drexel contract with the Redevelopment Authority and torn down. The cleared land would then have been made available to Drexel.

However, in view of the urgency of the situation, Drexel began to weigh the possibility of adapting the old warehouse to its own purposes. To enable them to arrive at a sound decision, a thorough analysis was required of all the relevant and contrasting factors which would bear on a) remodeling or b) demolishing and building anew. The analytic procedure set up for this purpose involved the following steps.

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From garage to classroom. Conversion of an automobile showroom and garage into classroom and laboratory space saved Fenn College, Cleveland, over a million dollars; also provided facilities which are equivalent to 4 buildings on most college campuses. Bottom and after photos show what was done with existing space. Joseph Cornell and Associates, architects.

METHOD OF ANALYSIS.

(A) The warehouse building was examined carefully to determine its condition, with particular attention to its structural health, since it was assumed that most of the mechanical parts would have to be replaced in any event.

(B) A preliminary plan was drawn to show how the building might be used and how it might be treated architecturally.

(C) A careful estimate of reconversion cost was prepared by taking off quantities by trade.

(D) A cost estimate for a new building of comparable size was worked out.

(E) A table was prepared showing the total cost of the conversion job at varying purchase prices for the old property, and a similar table was prepared showing the total cost of the new building at varying purchase prices for land for the new building. As soon as the purchase price of the old property and the cost of the new land was known, the two projects could be directly compared.

THE FINDINGS. The analysis found that the 50 foot width and 220 foot length of the warehouse made it highly satisfactory for conversion to academic use. Especially good, too, was the construction of the old building, which would permit a loading of 225 pounds per square foot, thereby allowing the laboratories to be located on the 5th, 6th, and 7th floors. Moreover, just behind Drexel's existing main buildings would be a highly desirable entrance to the campus from that direction. Its proximity to those buildings would permit Drexel to make intensive utilization of space through central scheduling.

These findings, combined with the expectations that conversion would cost at least $400,000 less than a new building of comparable size and that it would save at least a year's time, were persuasive enough to convince Drexel in favor of the conversion procedure.

From gauge to classroom. Conversion of an outmoded classroom and gauge into classroom and laboratory space saved Fenn College, Cleveland, over a million dollars, also provided facilities which are equivalent to 4 buildings on most college campuses. Before and after photos show what was done with existing space. Joseph Cimon and Associates, architects.

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IN THE PARKING PROBLEM

Every large urban enterprise has had to become involved in the garage business, like it or not. Department stores, restaurants, theaters, hospitals, all places where masses of people congregate mean masses of automobiles and places to put them. Again, the urban university is no exception. The automobile is as much a part of its operation as are text books and teachers.

Space for student and faculty cars has become almost as urgent a need as space for classrooms. But while university planners know they must erect buildings for classrooms, the idea of spending money to erect buildings for cars meets resistance—even though it may be more economical to do so than to provide open lots for that purpose. As with academic buildings themselves, parking space is a matter of density, and at some point in each particular case it becomes more economical to build up rather than to spread out.

Because the price of land is so high, Massachusetts Institute of Technology is planning a series of self-amortizing, multistory parking garages around the border of its campus. These will be cheaper than open lots. Cornell, with over 12,000 acres, is considering a similar program, not because of high land cost but to provide parking space accessible to faculty and staff where it is needed. The University of California at Los Angeles is planning 10 multistory

parking structures with a total of 17,000 parking the school grounds. Parkers will be required for close-in parking, less for distant spa

DREXEL'S PARKING PROBLEM COMES IN. At 1 90 per cent of the day students and close to evening students commute—some from distant intelligent planning required a look into the visions for parking. This meant a careful st of building up versus spreading out.

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THE SOLUTION. Here is what Drexel learned into the comparative costs of constructing tiple-story, open-air parking garages versus

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parking structures with a total of 17,000 parking spaces which will ring the school grounds. Parkers will be required to pay $50 per year for close-in parking, less for distant spaces.

DREXEL'S PARKING PROBLEMS TODAY. At Drexel Institute, where 80 per cent of the day students and close to 100 per cent of the evening students commute—some from distances up to 50 miles—intelligent planning required a look into the least expensive provisions for parking. This meant a careful comparison of the cost of building up versus spreading out.

Drexel's situation was typical of most urban institutions in that open space owned by them was, in most instances, scheduled for future academic building sites. Additional land for parking could be obtained only by purchasing and razing the buildings on it. Such land was costly, in some cases more than $10 per square foot. Ironically enough, to make matters worse, each campus improvement helped to raise further the price of adjacent land. In addition, there were such competing demands for parking space by non-Drexel people in the area that it became necessary for the university to provide supervision of its parking lots from early in the morning to late at night.

THE FINDINGS. Here is what Drexel learned from its investigation into the comparative costs of constructing and maintaining multiple-story, open-air parking garages versus the cost of purchasing

and maintaining the land for open lot parking. When the cost of land is near $7.00 per square foot, a multiple-story, open-air parking garage should be considered, using ramps for access to the floors. At this point the cost per square foot of the garage and the land plus surfacing is about equal. (Regional building costs, incidentally, do not vary sufficiently to change the concept of $7.00 as the check point; see *Engineering News-Record*, Building Cost Index, September 22, 1966.) With the garage, the cost of supervision to keep out undesirables is lower. Maintenance and snow removal are also lower.

Here again, of course, there is no pat answer. In each case the variable factors must be weighed—the availability and cost of land, the anticipated number of cars, and so on. But knowing that the neighborhood of $7.00 per square foot for land is the cutoff point beyond which it may be cheaper to build up rather than to spread out, can be a useful guide to other institutions in the planning of their own parking facilities.

Model of 5-story, open-air parking facility for the Colonial Parking of Cambridge, prepared for company of Daniel Shapiro, Walter and Bradshaw, architects

Four of 10 such multi-level structures for parking is under construction at UCLA campus. This one will park 991 cars, will cost about $900,000 to construct, and will blend into a campus hillside. Welton Becket and Associates, architects

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Model of 3-story open-air parking facility for the critical parking of cars, prepared for campus of Drexel Institute. Vickers and Scattergood, architects.

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colleges moved toward low use of facilities. A first step in the expansion study at Drexel Institute of Technology was a review and analysis of its present plant. Many institutions under pressure for more instructional space have been similarly stimulated into examining the efficiency of use of their existing space. Some colleges have undertaken their own studies; others have been the subjects of study by outside agencies. The results are generally shocking to those coming upon them for the first time. A study published in 1957* by the American Association of College Registrars and Admissions Officers presents the results of room utilization analyses in a number of institutions. Here are some of their figures:

a. Of 90 institutions reporting, 60 per cent indicated that their classrooms were used less than half of the total school hours per week.

b. Of 88 institutions reporting, 80 per cent indicated that their teaching laboratories were in

* Russell, John Dale and Doi, James I. *Manual for Studies of Space Utilization in Colleges and Universities*

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...ge ...school hours ... could result in the accommodation of 50 to 70 per cent more students without new construction. For these colleges this could be a saving of 12 to 17 million dollars in capital outlay."

FACTORS CONTRIBUTING TO LOW ROOM USE. The reasons for the inefficient, low utilization of space are as colorful as they are varied. Some of them are holdovers from the more leisurely patterns of American life that obtained in the era before the two great wars. Some have to do with tradition and nothing more—a reluctance to change customs that have prevailed over the years. In some cases what is involved is the self-image of an institution—the way it sees itself and wishes the world to see it. In still other cases it may be the status of faculty members which is at stake or the status of a college or department, as many urban institutions are loosely federated. There are other situations in which low use may be simply due to lack of the facts on the part of an institution, and a not infrequent factor is old, dilapidated space not really fit to use at all, which is consequently occupied as few hours a day as possible. Here are some examples of these gross space wasters and a few simple suggestions for improving utilization.

(1) By staggering the lunch hour (half of the students eating from 12:00 to 1:00 and half from 1:00 to 2:00) it is possible to make use of rooms that might otherwise all be empty for one common lunch hour. This was not possible when table service was provided for lunch, as a double shift of waiters would have been required. However, most colleges now have cafeteria service, and a staggered lunch hour is possible.

(2) In some institutions there are local customs that no recitation or lecture periods can be given immediately after lunch—the theory being that students are not sufficiently alert after eating. This superstition not only creates vacant classrooms and lecture rooms in the afternoon, but by virtue thereof results in empty labs in the morning, those hours then being given over to classes.

(3) In one institution the chemistry laboratory was used for only two sections of students and each section met twice a week for 2½ hour sessions. This meant the room was used a total of 10 hours a week. The reason for this was that each lab bench had only two lockers

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for storing the students' glassware, thus limiting the room to two sections since each student was held responsible for the breakage of his own glass. This is an example of the waste of a facility worth over $50,000 for the sake of a few dollars' worth of glass. Clearly it would have been cheaper to have a common locker for all students and let the institution absorb the negligible cost of the breakage. Even more logical would have been to build lockers for glassware stacked in banks along the walls. This would have made the room usable as many hours per day as there were sections to fill it.

(4) Another practice wasteful of space is to provide rooms with twice as many seats as students so that during examinations students can be seated in alternate seats to prevent copying. This practice is to be found most in subjects like mathematics, physics, chemistry, and the exact sciences, where answers to questions are more easily cribbed. In English, history, and even languages, the copying of answers is more difficult. (Apparently the so-called honor system is not in vogue in many places today.) One satisfactory solution to this problem is to schedule examinations in rooms other than the ones in which the subject is taught, usually large rooms. Exams can be scheduled in several subjects in the same room at the same time and students can be placed so that those taking the same test are not seated next to each other.

(5) The major and perhaps most universal cause of wasted space is the proprietary feeling which academic departments often develop about the classrooms or other facilities in their building with the result that rooms may stand empty better than half the time. Frequently an individual professor will lay claim to a particular room because it is near his office. He will not only resist teaching in any other room but may insist that no one else teach in his room.

This also contributes to another common practice which results in unused space, that of failing to give adequate consideration to the number of student stations (or seats) per room. As a result, because of convenience of location, large rooms are frequently occupied by small classes.

The remedy for both these ills is to have the scheduling of room use handled by a central agency and not by each department, with classes assigned to particular rooms based on the coordination of class size with room size.

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The remedy for both these ills is to have the scheduling of room use handled by a central agency and not by each department, with classes assigned to particular rooms based on the coordination of class size with room size.

(8) There is a wide fluctuation over the years in the popularity of various disciplines or studies as well as in the techniques of teaching. Hence the building of classroom facilities solely by only one department may create unused rooms in one building and a great shortage of rooms in another. (Of course these separated buildings often make a campus more attractive, and they do make it easier to get a donor when he can have a separate building carry his name.) On the other hand, though not essential for central scheduling, interconnected or integrated buildings such as those at MIT do facilitate the scheduling of room use by a central agency.

One university with a shortage of rooms in its Arts College but a surplus in its Engineering College is now teaching English, mathematics, and other Arts College subjects to engineering students in the Engineering building. This means that professors move from building to building, rather than students.

In a few places, Brandeis for one, classrooms for general university use are interspersed through all buildings to encourage intermixing of students and exchange of ideas. In many instances, however, waste of space is due to

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the fact that students *want* to be identified with the buildings that represent their own field of work. Because they take a special pride in being engineering students or arts students and wish to be identified as such, there is a resistance to attending classes in buildings other than "their own"—those which are identified with their major fields of study. On some campuses, science students, in their four years of undergraduate work, will never once have set foot in the school of business administration. This is true of faculty members as well. Whether such attitudes should be fostered, tolerated, or discouraged is a value judgment which each university administration must decide for itself. They must be aware, however, that where these attitudes exist they carry the high price tag of unused facilities.

(7) One large university has a faculty study being made to determine whether in certain subjects which might now have three recitations per week, it would be better to have one recitation or quiz period and let the class spend the other two hours in the library in independent study. This may not only conserve classroom space, but encourage more intellectual independence in the students.

A word of caution here:

Space utilization studies must be more than the arithmetic of efficiency experts. The educational aims and objectives of the institution must be taken into account, as well as the institution's image of itself. A high degree of utilization is at most a matter of efficient means to an end. Efficiency alone must not and can not dictate the arrangement and use of space. The quality and type of educational program, the purpose for which the space exists in the first place, must be the primary consideration which determines how it shall be used.

To return to Drexel, the analysis conducted there indicated that, in contrast to the usual low utilization figures such as those cited here, the use of rooms (according to the standard method of measuring) is extremely efficient. Classrooms were found to be in use about 75 per cent of the total possible time—excluding classes held by the Evening College and the Summer School which make for an even higher actual use.

STANDARD METHOD FOR MEASURING SPACE USE. Perhaps a short digression is in order here to define the "standard methods of measuring." These generally have as a base one of two

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The term used to designate t hours or periods that a room is class is the "room period use." of use of a room is determined of periods a room is actually in total possible periods that it within the framework of an inst dar and customs. Thus if classes particular institution at 8, 9, 10 and 3 on weekdays and at 8, 9, on Saturday, the maximum poss periods per week would be 45. ally occupied this room for 3 week, the percentage of room pe be 30 out of 45 or 66 and ⅔ pe

Room period use, while it is a standable measure, suffers the lim viding only partial information of space in that it reflects only which rooms are used. It does n extent of use of the space cont room. Thus a room may be occu when a class is held in it, but the unused space that results if

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STANDARD METHODS FOR MEASURING SPACE USE. Perhaps a short digression is in order here to define the "standard methods of measuring." These generally have as a base one of two units, the room and the student station (seats in a classroom or student places in a laboratory).

The terms used to designate the number of hours or periods that a room is occupied by a class is the "room period use." The efficiency of use of a room is determined by the number of periods a room is actually in use out of the total possible periods that it could be used, within the framework of an institution's calendar and customs. Thus if classes are held in a particular institution at 8, 9, 10, 11, 12, 1, 2, and 3 on weekdays and at 8, 9, 10, 11, and 12 on Saturday, the maximum possible number of periods per week would be 45. If classes actually occupied this room for 30 periods per week, the percentage of room period use would be 30 out of 45 or 66 and ⅔ per cent.

Room period use, while it is an easily understandable measure, suffers the limitation of providing only partial information about the use of space in that it reflects only the extent to which rooms are used. It does not describe the extent of use of the space contained inside a room. Thus a room may be counted as in use when a class is held in it, but will not reflect the unused space that results if the room con-

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tains 30 seats but is used by a class with only 15 members. From room period use an institution can find out how many additional classes could be accommodated, but not how many additional students. Therefore, for the most complete picture of the efficiency with which *total instructional space* is used, it is best to use both the room period measure and the student station measure.

The student station measurement, usually referred to as "student station period use" is essentially a count of the number of periods that student stations are occupied. The number of students who occupy a room each period it is in use are added together to give the total student station period use per week for that room. This figure becomes meaningful when it is related to either the number of existing student stations in the room or the number of possible student station periods per week. For example, if a room has a total of 30 seats and the maximum possible number of periods of use per week is 45, the total possible number of student station periods is 30 x 45 or 1350. If the classes average 25 pupils and the room is occupied for 30 periods, the student station use is 25 x 30 or 750. The measure of efficiency is then $\frac{750}{1350}$ or 55.6 per cent. In other words, student station periods are actually used 55.6 per cent of the time they might possibly be used.

In the former case, which relates the amount of use to the number of existing student stations in the room, the weekly student station period use, 750, is divided by 30, the number of existing student stations. The result here, 25, is not a measure of efficiency, but simply tells the average number of hours per week that a student station is occupied.

In the Drexel study only the room period use was considered for these reasons:

a. The student station use was already known to be high due to crowding in all classrooms. It was not uncommon for classrooms that had space for 15 students to be occupied by 25 students.

b. The purpose of the analysis was to determine total area requirements 10 years hence. An administrative decision had already been made that Drexel's classes would be planned to range from an optimum of 20 to a maximum of 30 students and that future class-

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a. The student station use was already known to be high due to crowding in all classrooms. It was not uncommon for classrooms that had space for 15 students to be occupied by 25 students.

b. The purpose of the analysis was to determine total area requirements 10 years hence. An administrative decision had already been made that Drexel's classes would be planned to range from an optimum of 20 to a maximum of 30 students and that future classrooms would be sized for 30. (Since Drexel Institute is a technological institution it does not have many elective courses. Elective courses in a college of arts and sciences often contribute to low student station use because of the difficulty of predicting how many people will elect the course.)

c. Laboratory and lecture rooms, which have great variation in student stations, were to be determined by hypothetical schedules of specific rooms—the most accurate way of determining size for these spaces and a method which takes fully into account the future student station use.

FACTORS CONTRIBUTING TO HIGH ROOM USE AT DREXEL. Analysis of room use at Drexel made it apparent that the high utilization of classrooms is due to universal use by any department—or the lack of proprietary ownership, coupled with central scheduling.

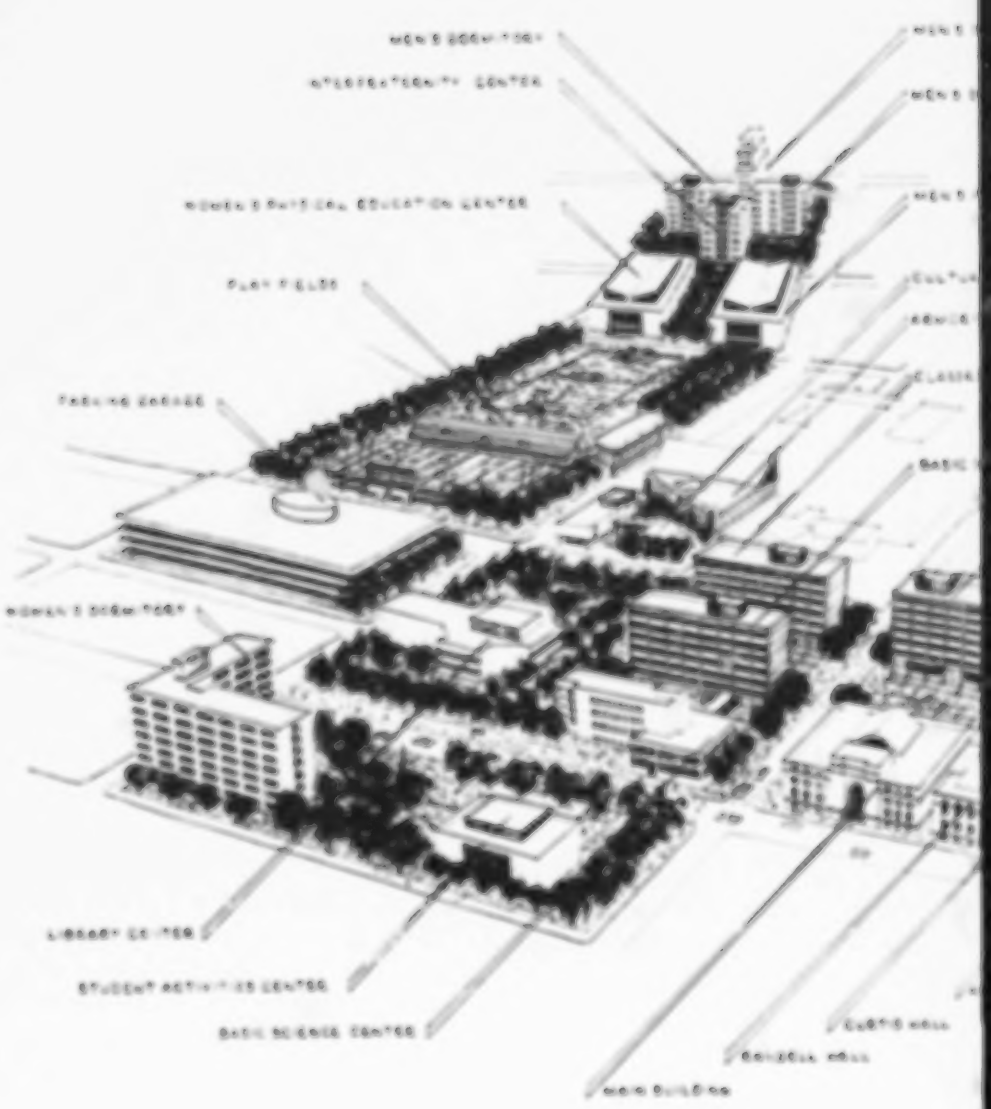
It was found that related to the high use of space is the fact that the Drexel plant is a compact one. The minimum length of class periods is defined by collegiate accrediting agencies. If classrooms and laboratories are too widely

Section I

separated, the time required for moving students from one location to another may involve the complete loss of a classroom hour. Each such class-hour loss represents an increase in the daily cost of operating the rooms involved.

THE FINDINGS. In the matter of the use and arrangement of space, then, the Drexel study found that a highly significant factor in their ability to provide a good education at a relatively low cost is the compactness of the teaching facilities which has made possible a high utilization of rooms.

To preserve that economy of operation it is essential to maintain compactness. Drexel plans, therefore, to locate all future buildings for increased enrollment as close as possible to the existing main building, the science center, and the library in order to keep time spent in the movement between buildings and classes at a minimum.



Arrangement of buildings on Drexel Institute campus as proposed in expansion study. Nolen and Swinburne, architects

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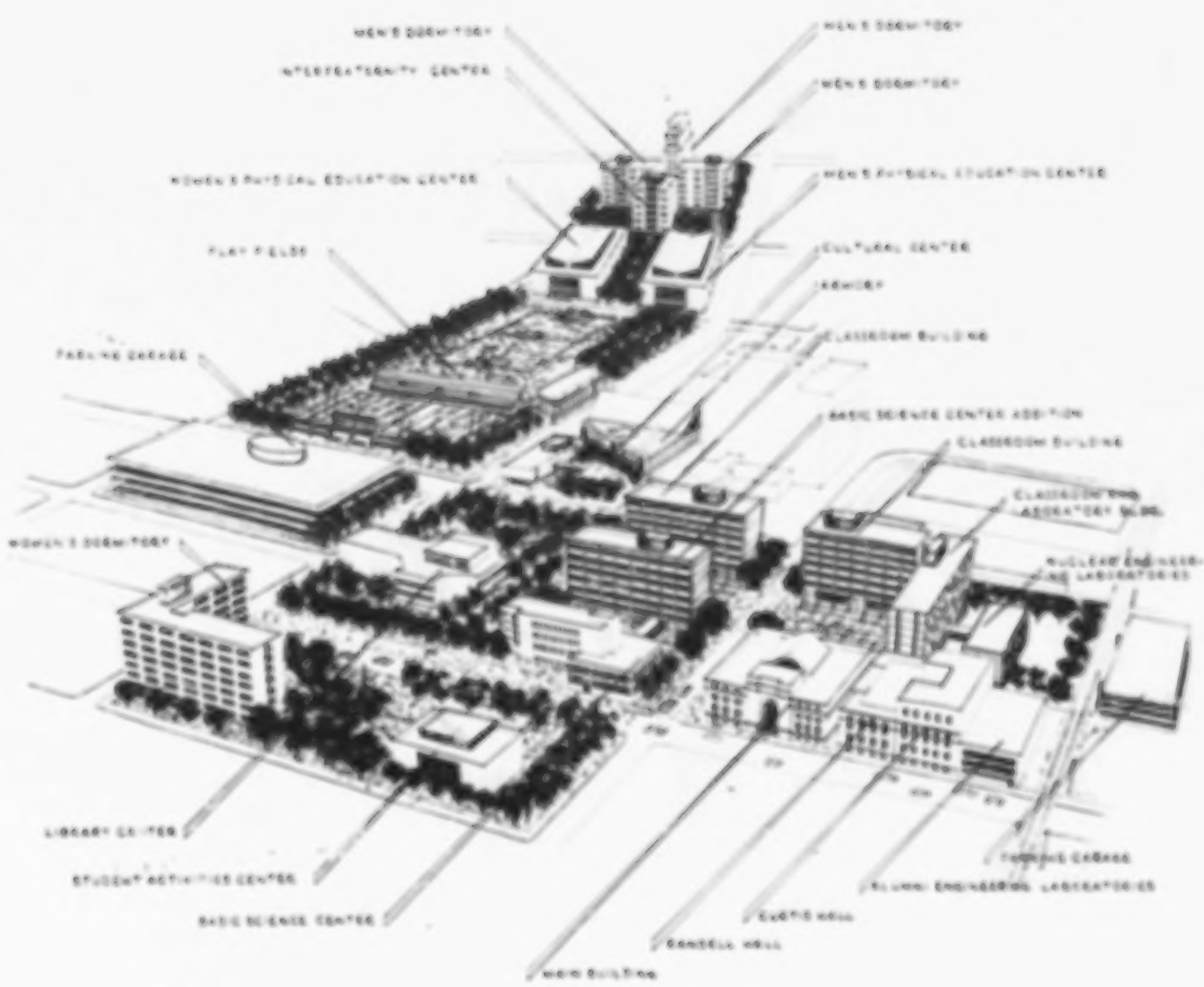

Arrangement of buildings on Drexel Institute campus as proposed in expansion study. Nolen and Swinburne, architects.

Section I

MISCONCEPTIONS AS TO SPACE NEEDS. It would seem superfluous to point out that any institution of higher education which plans additional buildings without a careful evaluation of the capacity of its existing facilities and an analysis of future needs is guilty of careless management.

Yet, too often our colleges and universities are inclined to assume that increased enrollment will require many more classrooms, laboratories, lecture rooms, and faculty offices than may be the case. The reason for this frequent assumption, as pointed out in the preceding section, is that so many institutions are not aware of how inefficiently they are utilizing the space they have. Therefore, they have no realization of the number of additional students they could accommodate without any expansion of instructional space.

For example, the Arts College of one large university was convinced that they were in need of at least one additional classroom building to take care of an expansion of about 30 per cent by 1970 and that, in addition, every department using laboratories would require more laboratory space. After a careful analysis using the Drexel method (detailed in these pages), it turned out that not only did they not need a new building, but they actually had 19 rooms, each of a capacity of 50–149 students, beyond what they would need even with the 30 per cent enrollment increase. The study did indicate a need for 4 laboratories and 1 small classroom, but these, along with office space for the increase in faculty, could easily be provided by converting some of the unneeded large classrooms. This was far removed from the need for a new building.

Another example: A women's college expected an increase of 20 per cent in student population. Inasmuch as funds were available to finance new dormitories, it was decided to convert an existing dormitory with 50 beds to faculty offices, seminar rooms, and small classrooms to take care of the added students. New dormitory facilities would be built to replace the one that was being converted. However, examination of actual room schedules indicated that classrooms
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WEAKNESSES IN THE SQUARE FOOT PER PUPIL METHOD OF MEASURING FUTURE SPACE REQUIREMENTS. In addition to the false initial assumption that a sizable increase in student enrollment automatically means increased physical facilities, there is another factor which contributes to miscalculations about the need for future space—the square foot per pupil gauge commonly used to compute what the need will be.

This is a procedure which, in its essential form, assigns X number of square feet as necessary for a single student and then multiplies the X by the total number of anticipated students to yield the final quantity of new space that will be required. There are a number of deficiencies inherent in this process which make for inaccurate and incomplete results. For example, if the existing square feet per student is used as a guide, then the inefficient

Section I

use of space which may already exist is merely perpetuated. If, on the other hand, the square feet per student figures of another institution are used, the institution may be grafting on the odd habits of a neighbor not comparable in courses, curricula, or class sizes. Further, the process makes no allowance for the wide difference in space needs of widely varying courses. It also does not take into account the relationship of the shape of space to teaching techniques, or efficiency of space layout.

THE DREXEL METHOD AND ITS STRENGTHS. At Drexel Institute of Technology, where balancing the books is contingent upon the high utilization of the physical plant, they were determined to project space requirements that would be precise and accurate in order to insure a high degree of utilization in their new buildings. To that end a method of calculating space requirements was developed which departs from the square foot approach.

As will be seen from the step-by-step outline of the method presented here, its strength is derived from the fact that its calculations are based on the specific courses that will be given, on the types and sizes of space, and on the frequencies of use of the space which these courses require.

A further advantage of the Drexel method is that the procedures which must be followed leave behind a historical record of the analysis of future needs. This is valuable because it permits the periodic rechecking of space requirements as courses and/or teaching methods change, or as the proportion of student enrollment in various courses may change.

Moreover, a by-product is precise information as to the number of new faculty members who will be required. Last but not least, another of its virtues is that it necessitates close consultation with the faculty itself, drawing upon its information and experience, and thereby inviting its confidence in the result.

Here then, is the step-by-step procedure which was followed at Drexel Institute to determine the amount and type of space that would be required to accommodate an 85 per cent increase in student enrollment. A sample of the form used for each procedural step, which will be referred to as an Exhibit, is attached at the end of this section as an aid to other institutions.

1. METHOD USED TO DETERMIN
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(1) Each department head w
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particular department. The siz
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from course to course within
(See Exhibit A for instructions
of Drexel's several colleges in th

(2) The Admissions Office w
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crease in enrollment.

(3) A master form was d
hibit B)—and instructions for
C)—on which was listed, by de
course taught in Drexel's day
each course the following in
shown:

Number of students in the course.
Number of sections or groups of
course.
Optimum c.. most desirable numbe
section.
Maximum number of students wh
in a section.

Section 2

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A. METHOD USED TO DETERMINE ADDITIONAL CLASSROOMS NEEDED:

(1) Each department head was asked to determine what number of students would constitute the most optimal unit of growth in his particular department. The size of the units varied from department to department and from course to course within departments. (See Exhibit A for instructions issued to deans of Drexel's several colleges in this connection.)

(2) The Admissions Office was consulted in order to determine the probable breakdown by major fields of the projected 85 per cent increase in enrollment.

(3) A master form was developed (Exhibit B)—and instructions for its use (Exhibit C)—on which was listed, by department, every course taught in Drexel's day colleges. For each course the following information was shown:

Number of students in the course, fall term, 1959.
Number of sections or groups of students in the course.
Optimum or most desirable number of students per section.
Maximum number of students who could be taught in a section.

Type of room required (classroom, lecture room, etc.).
Number of periods per week.
Length of period, and
Time needed to prepare or dismantle demonstration rooms.

(4) The next columns (16–31) of the master form showed, by school or department, the number of additional students who might be expected by 1970. Figures in this set of columns (16–31) added to enrollments in the fall of 1959 (Col. 3) gave, course by course, the expected total for 1970 (Col. 36). A division of this figure (Col. 36) by the optimum number of students per section (Col. 5) revealed the number of sections to be accommodated in 1970 (Col. 37).

(5) The projected number of sections for 1970 (Col. 37) was multiplied by the number of hours per section per week (Col. 38) in order to determine the total room-hours per week (Col. 39).

For classrooms it was assumed that Drexel's current high utilization factor (75 per cent) could be maintained. Therefore, it was possible to divide the total room hours (Col. 39) by 31 to determine the number of classrooms that would be required (Exhibit D). The divisor 31 represented 75 per cent of the total number of daytime hours between 9:00 and 5:00, Monday through Friday, during which classes for instruction could be held.

B. METHOD USED TO DETERMINE ADDITIONAL LABORATORIES AND LECTURE ROOMS NEEDED:

Because of the specialized nature of laboratories and lecture rooms, it was not possible to use the simple arithmetic indicated under A5 above. Therefore, the laboratory and lecture classes projected for the year 1970 were actually "scheduled" by hours and days in order to arrive at the total additional need (Exhibit E).

C. METHOD USED TO DETERMINE ADDITIONAL FACULTY OFFICES NEEDED:

Calculations under heading A4 had indicated the number of sections of each course to be taught. These figures were given to the department heads and they were asked to indicate both the present size of their teaching staffs and the faculty additions that would be necessary by 1970 (Exhibit F). From these figures it was possible to predict the number of faculty offices—(and future
though not a part of th
1970 (Exhibit G).

The findings of Dre
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Section 2

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The findings of Drexel's analysis based on this procedure are omitted from this report since they apply only to Drexel and have little applicability to other institutions. Neither are they germane to this section of this report, which is primarily concerned with the method used to determine future space needs rather than the results.

The exhibits

Section I

EXHIBIT A

Memo to the Deans: July 27, 1959

Through a grant made by the Educational Facilities Laboratories, Inc., to Drexel, studies are being made this summer to explore ways of expanding our physical facilities to meet the growth in student enrollment of 85 per cent by 1970 as projected in the Alderson and Sessions report. We are seeking ways of expansion which will be logical, economical, and flexible and which will permit us to continue our high utilization of space, the economy of which is essential to our successful operation.

Frequently, future space requirements are determined by a purely statistical method based upon the number of square feet per student needed for classrooms, laboratories, lecture rooms, and staff offices. This approach has weaknesses. It cannot adequately allow for the wide variation in space needs of widely varying courses, and hence too much or too little of one kind of space or another may be provided. It gives no concise consideration to the size of individual rooms for various uses other than by a consensus. It leaves no base or background for review of space needs as the nature of the courses of instruction may change or as the proportion of student enrollment in various courses may change.

We hope to develop an approach and a result which will be somewhat different and which will overcome some of these deficiencies of the square foot per student method.

It seems logical to us to approach the problem through consideration of the specific courses of instruction we give and the types and sizes of space, and frequencies of use which these courses require. We are agreed that there is an ideal unit or increment of growth in any curriculum, based upon the most economic use of instructional time, and that the size of this increment may vary substantially between various schools or departments. Although we have no illusions that we can control enrollment to the most ideal sizes or blocks, it still remains the logical unit around which to plan space needs. In our expansion we will grow from tight vests (with which we are presently familiar) to rather loose and oversized clothing, and then back to the tight vests again.

After several meetings of the deans we
information which seems essential to d
space needs of Drexel. We must get th
you. An outline of some of the basic
the information wanted is attached.

It would be most helpful if we could h
to be filled in by you on the accompan
(Exhibit B) by _____.

Determining the Future Space Requ

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enrollment should increase 85 pe

(2) It will be assumed that the grow
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a. The Graduate School
b. Science programs leading
c. Doctorate programs

(3) It will be assumed that the grow
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instruction and that this will e
adequate for the evening college
evening college will be tailored

(4) It will be assumed that:

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b. There will be no 8 A.M.
c. One 2-hour period in an
used for student activit
d. One 2-hour period in an
used for military train

Section 2

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July 27. 1959

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...ed clothing, and then back to the

After several meetings of the deans we have worked out the information which seems essential to determine the future space needs of Drexel. We must get this information from you. An outline of some of the basic assumptions and of the information wanted is attached.

It would be most helpful if we could have this information, to be filled in by you on the accompanying spread sheets, (Exhibit B) by _____.

Determining the Future Space Requirements at Drexel

(1) This determination will be made on the over-all estimate made by Alderson and Sessions that the total student enrollment should increase 85 per cent by 1970.

(2) It will be assumed that the growth will be generally uniform in all colleges and courses except where known factors indicate otherwise, such as:

   a. The Graduate School
   b. Science programs leading to a B. S. degree
   c. Doctorate programs

(3) It will be assumed that the growth of the physical plant will be fitted to the requirements for day instruction and that this will either be more than adequate for the evening college or the size of the evening college will be tailored to the space available.

(4) It will be assumed that:

   a. There will be no Saturday morning classes.
   b. There will be no 8 A.M. classes.
   c. One 2-hour period in an afternoon will be used for student activities.
   d. One 2-hour period in an afternoon will be used for military training.

(5) It will be assumed that no more space will be added to the library by 1970 and that the School of Library Science will only report the following information:

a. The maximum student capacity of the new School of Library Science building.
b. Number of additional teaching and clerical staff required to take care of that capacity.
c. The maximum student population at Drexel which the library will accommodate.

(6) Other deans will report as follows (again, in the appropriate columns of the spread sheets):

a. What unit or increment of growth in number of students is the most economic in each of the areas of instruction such as Civil Engineering, Electrical Engineering, Home Economics, Business Administration, Physics majors, etc. The size of these units will vary depending on the nature of the courses and the number of students needed to get the maximum use of the instructional time. Consideration must be given to each term of the course and the effects of attrition on the later terms.

b. Number of students for each increment of growth; the number of sections required for each course of instruction for each term; the optimum and maximum number of students per section; the nature of the room required for instruction - recitation, lecture, laboratory, etc.; and whether this room is a "specialized room" - that is, a room specially equipped for that particular course - and can be used only for that course or may be used for other purposes.

c. Where a course is given by another department, indicate the total number of students only. The number of students per section and number of sections will subsequently be determined by the other department.

d. For each increment of growth, report any increase in teachi administrative staff, by titl professor, 2 assistant profes 1 secretary, 1 clerk."

(7) After reports are assembled from each the number of students reported as re from other departments will be abstra reported to each of the servicing dep indications of the number of sections number and maximum number per section

(8) The Dean of Admissions will predict t enrollment in the various areas of in with the dean or department head.

Section 2

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he total number of students only. The
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d. For each increment of growth, the dean will also report any increase in teaching, clerical, or administrative staff, by title, such as " 1 professor, 2 assistant professors, 2 instructors, 1 secretary, 1 clerk."

(7) After reports are assembled from each department or school, the number of students reported as requiring service courses from other departments will be abstracted, assembled, and reported to each of the servicing departments for their indications of the number of sections and the optimum number and maximum number per section.

(8) The Dean of Admissions will predict the growth of student enrollment in the various areas of instruction on conference with the dean or department head.

Section I

EXHIBIT A

DREXEL INSTITUTE OF TECHNOLOGY

SPACE REQUIREMENTS

CR — CLASSROOM RECITATION
LR — LECTURE ROOM
SR — STAFF ROOM
L — LABORATORY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
ASSIGNED ROOM	COURSE	FALL 1958 No. OF STUD	No. OF SECT	SPR. 1959 No. OF STUD	MAX No. OF STUD.	TYPE OF ROOM	PERIODS PER WEEK	PERIODS UNDERGRAD NOCL.	PERIODS UNDERGRAD TIME	ASST. STUD	PRESENT SPACE	ANTICIPATED INCREMENTS BY SCHOOLS																								TOTAL	
												ME	EE	CE	Mar E	Ch E	Phys	Chem	Biol. Sci.	4-1/2 BA	Adm Sec	Bus Yr	Ret Mer	Jr Sec'l.	Coop BA	Comm Engg.	Home Ec.								

Section 2

DREXEL INSTITUTE OF TECHNOLOGY

SPACE REQUIREMENTS

SHEET NO. _____

DR. _____

DATE _____

6	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
								ANTICIPATED INCREMENTS BY SCHOOLS																														
				PRESENT SPACE				ME	EE	CE	MetE	ChE	Phys	Chem	Biol Sc.	4-1/2 BA	ADM SEC	Bus TY	Art Mkt.	B Occ.	Coop BA	Comm ENG.	HOME EC														

TOTAL	BTO		
	SALOP SEPT.	PALMER SEPT.	TOTAL PALMER

Section I

EXHIBIT C

INSTRUCTIONS FOR USE OF MASTER FORM (EXHIBIT B)

1. Have a quantity of "spread sheet" forms (Exhibit B) duplicated for distribution to each department. Number these by department. Suggest the form be enlarged to get more space in each column. Department heads will fill in the required information so that the form becomes part of the departmental report. Information from these reports will subsequently be abstracted to provide a summary of present and future needs. A copy of the same form may be used for a final summary.

2. Column 1 is to be used to show the actual room number of the room now used for lecture or lab courses - not necessary for classrooms.

3. Column 12 is to be used to indicate if room presently occupied - lecture or laboratory - is unsatisfactory for the course.

4. Abstract from department reports the added number of students expected in each course by 1970 and enter in department column on "spread sheet" - from those reports, columns 2,7,8,9,10, and 16 through 31 can also be filled in.

5. A sheet or sheets for such courses as English, Math, Social Science, Language, or any other courses not falling in a major department category will probably be needed.

6. When columns 16-31 are complete, suggest meeting with department heads to check the following:

   a. Actual room number for lecture or lab courses - Column 1.
   b. What other courses can be handled in same lab or lecture room.
   c. Number of students in course in Fall 1959 (or Spring 1959) - Column 3.
   d. Number of sections in course in Fall 1959 (or Spring 1959) - Column 4.
   e. Optimum number of students per
   f. Maximum number of students per
   g. Verify type of room (Column 7) be used for only that course.
   h. Check periods and length of per
   i. Check if "preparation time" mus or lecture room - Column 10.
   j. Check to see that every course ment is shown in Column 2.

7. Add Column 3 to 16 through 31 and i (Total Students).

8. Divide Column 36 by Column 5 to get Sections).

9. Multiply Column 8 by Column 9 and a Room-Hours/Wk/Section - Column 38.

10. Multiply Column 37 (No. of Sections Wk/Section) to get Total Room-Hour

11. Add up total <u>classroom hours only</u> b on bottom of last departmental shee

12. Prepare actual <u>room schedule</u> by hou each laboratory and lecture room (c such as seminar) now in existence. Schedule for laboratory and lecture

13. After available hours are used up f schedule card for 202-A - then 202- be possible to determine how many r be needed. See Exhibit E_1.

14. Abstract for Home Economics only th that department (service courses su etc.). The Home Economics Departme handled separately.

Section 2

OF MASTER FORM (EXHIBIT B)

d sheet" forms (Exhibit B)
on to each department. Number
gest the form be enlarged to
lumn. Department heads will
rmation so that the form becomes
report. Information from these
be abstracted to provide a
ture needs. A copy of the same
nal summary.

show the actual room number of
ture or lab courses - not

o indicate if room presently
oratory - is unsatisfactory for

reports the added number of stu-
urse by 1970 and enter in depart-
eet" - from those reports, columns
h 31 can also be filled in.

h courses as English, Math,
or any other courses not
ment category will probably

nplete, suggest meeting with
the following:

r lecture or lab courses - Column 1.
n be handled in same lab or

course in Fall 1959 (or Spring

course in Fall 1959 (or Spring

e. Optimum number of students per section - Column 5.
f. Maximum number of students per section - Column 6.
g. Verify type of room (Column 7) and if that room can be used for only that course.
h. Check periods and length of period - Columns 8 and 9.
i. Check if "preparation time" must be allowed for lab or lecture room - Column 10.
j. Check to see that every course taught by the department is shown in Column 2.

7. Add Column 3 to 16 through 31 and indicate in Column 36 (Total Students).

8. Divide Column 36 by Column 5 to get Column 37 (Number of Sections).

9. Multiply Column 8 by Column 9 and add Column 10 to get Room-Hours/Wk/Section - Column 38.

10. Multiply Column 37 (No. of Sections) by Column 38 (Rm. Hrs./Wk/Section) to get Total Room-Hours - Column 39.

11. Add up total <u>classroom hours only</u> by department and show on bottom of last departmental sheet.

12. Prepare actual <u>room schedule</u> by hours and days of week for each laboratory and lecture room (or other special room such as seminar) now in existence. See Exhibit E, Sample Schedule for laboratory and lecture rooms.

13. After available hours are used up for <u>Rm. 202</u> make a schedule card for 202-A - then 202-B, etc. Thus it will be possible to determine how many rooms <u>like</u> 202 will be needed. See Exhibit E_1.

14. Abstract for Home Economics only the courses outside of that department (service courses such as Chemistry, Biology, etc.). The Home Economics Department itself will be handled separately.

EXHIBIT D

DREXEL
SUMMARY OF CLASSROOM NEEDS

Classroom Hours -- 1970

Engineering	1479	
Business Administration	997	
Service Departments	1029	
	3505 ÷ 31 =	114 C.R.
Existing Classrooms		76
Additional Required Classrooms		38

Section I

EXHIBIT E

LABORATORY AND LECTURE ROOM SCHEDULE

Electrical Engineering Lab. Room No. _____ (Seating)

HR.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
8:00						
9:00						
10:00						
11:00						
12:00						
1:30						
2:30						
3:30						
4:30						

EXHIBIT E-1

Electrical Engineering Lab. Room No. _____ (Lecture)

HR.	MON.	TUES.	WED.	TH
8:00				
9:00				
10:00				
11:00				
12:00				
1:00				
2:00				
3:00				
4:00				

Section 2

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Electrical Engineering Lab. Room No. _____ Undergraduate Addition - 1973

HR.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
8:00						
9:00						
10:00						
11:00						
12:00						
1:00						
2:00						
3:00						
4:00						

EXHIBIT F

Present Teaching Staff and Faculty Additions Required by 1970

Memo To Deans:

Attached are lists showing the anticipated number of sections in each course in 1970. From this we are determining the space required for classrooms, laboratories, lecture rooms, and all spaces needed for teaching.

We must also now determine the space required for the teaching and administrative staff. Will you kindly ask each department head to list for you the number of people, by title or classification, who are presently employed, and the number of people who will be needed to carry this teaching load in 1970.

A sample listing might look like this:

	1960	1970
Professors		
Associate Professors		
Assistant Professors		
Instructors		
Laboratory Assistants		
Lecturers		
Clerks		
-etc.-		

Will you kindly review and approve the list and forward it to me not later than_____.

(Signature)_____

Section I

EXHIBIT G

PRESENT FACULTY OFFICES AND ADDITIONAL OFFICES REQUIRED BY 1970

Department	Professors		Associate Professors		Assistant Professors		Instructors		Lab. Assistants		Lecturers		Secretaries	
	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70
Home Economics	7	9	9	10	6	8	8	9	5	6	1	0	3	6
Chemical Eng.	1	2	1	1	1	2	1	2	2	3	0	0	1	1
Civil Eng.	2	3	2	4	4	8	6	9	1	2	1	0	1	2
Mech. Eng.	6	12	4	10	4	10	7	16	0	0	1	2	1	2
Metal. Eng.	1	2	1	1	1	2	5p/t	3	0	0	0	0	0	1
Elec. Eng.	3	6	5	9	3	9	11	14	3	5	0	0	1	1
Physics	4	5	2	5	3	7	4	10	1	2	0	0	1	2
Chemistry	5	10	5	10	1	4	4	8	10	15	1	1	1	2
Mathematics	4	8	4	10	3	10	9	10	0	0	0	0	1	1
Merchandising	1	1	2	1	0	1	0	1	0	0	0	0	0	0
Accounting	1	2	2	3	4	7	3	5	0	0	0	0	0	1
Economics	1	4	5	5	2	6	2	8	0	0	4	5	0	2
Social Science	1	4	4	7	4	8	2	3	0	0	2	3	1	1
Secretarial	3	1	0	3	2	1	0	3	0	0	0	0	0	0
English	2	6	6	10	5	10	9	18	0	0	0	0	0	0
Finance	1	2	1	3	1	3	1	2	0	2	7	3	0	1
Physical Ed.	0	0	3	5	0	0	4	8	0	0	0	0	0	0
Foreign Language	0	1	1	2	1	0	2	3	0	0	0	0	0	0
TOTAL	43	78	57	99	45	96	78	132	22	35	17	14	12	23
People per Office		1		2		2		2		0		5		4
OFFICES REQUIRED 1970		78		50		48		66		0		Allow-3		Allow-7

Total Offices Needed 1970 = 254
Existing Offices 1960 = 136
Additional Offices Needed = 118

Section 2

FACULTY OFFICES AND ADDITIONAL OFFICES REQUIRED BY 1970

...rs	Associate Professors		Assistant Professors		Instructors		Lab. Assistants		Lecturers		Secretaries		Clerks		Misc.	
...0	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70	1960	'70
															Lab.	Sup.
9	9	10	6	8	8	9	5	6	1	0	3	6	0	0	0	1
2	1	1	1	2	1	2	2	3	0	0	1	1	0	0	0	0
3	2	4	4	8	6	9	1	2	1	0	1	2	0	0	0	0
2	4	10	4	10	7	16	0	0	1	2	1	2	0	1	3	7
															Lab.	Techs.
2	1	1	1	2	5p/t	3	0	0	0	0	0	1	0	0	1	1
6	5	9	3	9	11	14	3	5	0	0	1	1	0	0	0	0
5	2	5	3	7	4	10	1	2	0	0	1	2	0	0	5	10
0	5	10	1	4	4	8	10	15	1	1	1	2	4	7	0	2
8	4	10	3	10	9	10	0	0	0	0	1	1	0	0	0	0
1	2	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
2	2	3	4	7	3	5	0	0	0	0	0	1	0	0	0	0
4	5	5	2	6	2	8	0	0	4	5	0	2	0	0	0	0
4	4	7	4	8	2	3	0	0	2	3	1	1	0	0	0	0
1	0	3	2	1	0	3	0	0	0	0	0	0	0	0	0	0
6	6	10	5	10	9	18	0	0	0	0	0	0	0	0	0	0
2	1	3	1	3	1	2	0	2	7	3	0	1	0	0	0	0
0	3	5	0	0	4	8	0	0	0	0	0	0	0	0	0	0
1	1	2	1	0	2	3	0	0	0	0	0	0	0	0	0	0
8	57	99	45	96	78	132	22	35	17	14	12	23	4	8	9	21
1		2		2		2		0		5		4		4		0
8		50		48		66		0		Allow-3		Allow-7		Allow-2		0

= 254
= 136
= 118

Section I

OTHER EFL PUBLICATIONS

- Here They Learn
  EFL's first annual report
- Ring the Alarm!
  A memo to the schools on fire and human beings
- The Cost of a Schoolhouse
  Planning, building and financing the schoolhouse
- Design for ETV—Planning for Schools with Television
  Facilities needed to accommodate instructional television
- Profiles of Significant Schools: A Continuing Series
  Belaire Elementary School, San Angelo, Texas
  Heathcote Elementary School, Scarsdale, New York
  Montrose Elementary School, Laredo, Texas
  Public School No. 9, Borough of Queens, New York
  Two Saginaw Middle Schools, Saginaw Township, Michigan
  A & M Consolidated Senior High School, College Station, Texas
  Hillsdale High School, San Mateo, California
  Newton South High School, Newton, Massachusetts
  North Hagerstown High School, Hagerstown, Maryland
  Rich Township High School, Olympia Fields, Illinois
  Wayland Senior High School, Wayland, Msasachusetts
  Schools for Team Teaching—ten representative examples
- New Schools for New Education
  Report on the University of Michigan conf
  design

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- No. 1
  Conventional Gymnasium vs. Geodesic Fie
  West Bethesda High School, Montgomery
- No. 2
  Space and Dollars: An Urban University E
  Based on the case of Drexel Institute
- No. 3
  Laboratories and Classrooms for High Sch
  A report of the American Institute of Physic
  Design of Physics Buildings

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Section 2

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schools on fire and human beings
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—Planning for Schools with Television
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entary School, Scarsdale, New York
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CASE STUDIES OF EDUCATIONAL FACILITIES